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Prof. Jin Au Kong

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Research Laboratory of Electronics
Massachusetts Institute of Technology
77 Massachusetts Avenue
Cambridge, MA 02139

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The polarimetric passive techniques have been used for the retrieval of ocean wind speed and directions by measuring the polarimetric brightness temperature of the ocean surface. However, under high wind conditions, the presence of foam will significantly affect the brightness temperature signature of the plain ocean surface. In addition to the empirical model of the foam contribution to the thermal emission, the previous theoretical studies are mostly based on simple geometry models, which may not reflect the realistic physical situation.

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The **RESEARCH LABORATORY *of* ELECTRONICS**
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
77 MASSACHUSETTS AVENUE
CAMBRIDGE, MASSACHUSETTS 02139-4307

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Marie C. Colton, ONR 321
Program Officer
Office of Naval Research
Ballston Center Tower One
800 North Quincy St.
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Mary S. Greene
RLE Financial Assistant, Room 36-437

cc: Prof. Kong (1)
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OSP 6780700

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Polarimetric Microwave Remote Sensing of the Ocean Surface

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Project Staff
Professor Jin Au Kong, Dr. Y. Eric Yang, Yan Zhang, Peter Orondo, Chi O. Ao

The polarimetric passive techniques have been used for the retrieval of ocean wind speed and directions by measuring the polarimetric brightness temperature of the ocean surface. However, under high wind conditions, the presence of foam will significantly affect the brightness temperature signature of the plain ocean surface. In addition to the empirical model of the foam contribution to the thermal emission, the previous theoretical studies are mostly based on simple geometry models, which may not reflect the realistic physical situation.

In our study, we modeled the foam as a volume with thin-film water bubbles. The radiative transfer (RT) equations were set up in this volume with the boundary conditions linking the atmosphere and the ocean surface. At the frequency we were interested in, we assumed the penetration depth of the electromagnetic wave in the foam layer to be much shorter than the foam thickness, the electromagnetic wave interaction between the foam layer and the ocean surface was ignored and the formulation was greatly simplified. The RT equations in the foam layer were solved by using an iterative method, and a closed form solution was obtained up to the first order. In the solution of the RT equations in the foam layer, the terms provide the physical meaning of the wave propagation and interaction between the atmosphere and the water bubbles in the foam. For the interface of the atmosphere and the open ocean surface, thermal emission is the sum of the reflection of down-going atmospheric thermal emission and the thermal emission from the plain ocean surface. The total thermal emission at the radiometer is the sum of the contribution from the atmosphere-foam interface and the atmosphere-plain ocean surface interface, weighted by the foam coverage. In the one-scale model, in which only the small-scale ocean waves are taken into account, we found that the atmospheric thermal emission is comparable to the foam's thermal emission for the co-polarized waves. The two-scale model is more realistic in comparison with the one-scale model, however it requires much more computational time since two more folds of integration are needed for averaging over the slope of large-scale ocean waves. The propagation of the specific intensity is also modeled using the RT theory for the atmosphere. Since the scattering in the atmosphere is ignored, the only existing parameter in the RT equations is the absorption coefficient that is obtained from the millimeter-wave propagation model (MPM) with the use of standard atmospheric profile data available in the US Standard Atmosphere 1976. Although it is difficult to obtain the atmospheric profile data at the particular measurement site, a further study is suggested to validate the atmospheric emission model using measurement data.

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